Financial Reporting Council

THE USE OF TECHNOLOGY IN THE AUDIT OF FINANCIAL STATEMENTS

AQR THEMATIC REVIEW

MARCH 2020

The Financial Reporting Council (FRC) is the UK's independent regulator responsible for promoting high quality corporate governance and reporting to foster investment. The FRC sets the UK Corporate Governance and Stewardship Codes and UK standards for accounting and actuarial work; monitors and takes action to promote the quality of corporate reporting; and operates independent enforcement arrangements for accountants and actuaries. As the Competent Authority for audit in the UK the FRC sets auditing and ethical standards and monitors and enforces audit quality.

AQR Thematic Review

The Use of Technology in the Audit of Financial Statements

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1 EXECUTIVE SUMMARY

Does the use of technology improve audit quality? In our 2017 review '*The Use of Data Analytics in the Audit of Financial Statements*' we reported that while data analytics had the potential to improve audit quality, its use to generate audit evidence was limited in areas other than journal entry testing. Three years on and we have refreshed our research and analysis and expanded it to consider the audit firms' use of emerging technology.

The use of **automated tools and techniques**[1] in the form of **audit data analytics** (ADA) is now routine at the largest UK audit firms, with considerable investment being made in implementing the infrastructure, methodology and training required to use these techniques effectively. Other emerging technologies, such as machine learning and predictive analysis, although largely at a research stage, present further opportunities to improve audit quality but raise challenges for both audit firms and regulators in terms of compliance with standards.

Automated tools and techniques are now deployed with methodology, training and support.

Audit firms' approaches to the implementation of ADA tools now typically follow what we observed as instances of good practice in 2017, with the technology deployed as part of a package with associated methodology, training and support (section 2.3). This enables audit teams to understand the audit evidence that the technique generates, and the additional audit procedures necessary to address the relevant assertions appropriately. The documentation of that evidence on the final audit file is, in general, much improved. ADA has become 'business as usual' for many audit teams, with the current generation of audit recruits developing relevant skills as an intrinsic part of their training.

Firms have established different priorities in their adoption and rollout of **automated tools and techniques** (section 2.3). However, all are continuing to develop and enhance their use of **technological resources**. To date, the audit of revenue and the use of ADA for risk assessment are the two audit areas with the most prevalent use of ADA beyond journal entry testing. We see only isolated examples of pervasive use of ADA across multiple financial statement line items on an individual audit, reflecting the firms' focus on building capability in specific areas. The **technological resources** we see deployed on the audits we inspect are generally in line with the firms' articulated deployment strategies.

Firms have invested considerably in the infrastructure required to capture, collate and organise data completely and accurately into a format their **automated tools and techniques** can analyse (section 2.3.3). This infrastructure serves the data requirements for the current generation of ADA tools. It also provides a foundation for the needs of emerging technologies. The auditor's ability to extract useful data remains dependent on the availability of granular data at the audited entity, and the capability and willingness of management to provide that data for auditor analysis.

Emerging technologies are largely at the research or pilot stage.

Emerging technologies such as machine learning and natural language processing offer the

[1] A full definition of terms in bold is provided in the Glossary at the end of this document

potential to improve audit quality (section 2.6). These are largely at research or pilot stage with some rollout for 2019 year-end audits that we have not yet assessed. Audit firms are seeking to use these tools to identify unusual journal entries or contract terms that would not otherwise be found by a human auditor. The audit firms have also invested and deployed technology to drive audit efficiencies through robotic process automation and smartphone applications. These automated tools collect and collate audit evidence to reduce administrative and repetitive tasks. We look to the market to develop innovative solutions. We have included our pragmatic approach to inspecting some of these new technologies (section 4.1) and our future plans for assessing the governance and risk management of these tools (section 4.3).

Technology offers challenges to auditors and regulators in terms of compliance with principles-based auditing standards (section 3.1). These principles remain constant in order to be applied in specific circumstances. Our inspection approach is not authoritative guidance or necessarily complete; it has arisen from our observation of what we deem to be good practice. Alongside this AQR thematic review we are publishing a discussion paper on '*Technological Resources: The Use of Technology to Enhance Audit Quality*', seeking stakeholder views to inform the FRC's audit policy work programme on these challenges.

Third party vendors are active in the market, with products ranging from software to services. These relationships present audit quality opportunities for expanding ADA capabilities in audit firms without bearing the full cost of investment or building internal teams (section 2.7).

The use of **automated tools and techniques** may promote audit quality by deterring fraud and the manipulation of accounts (section 2.2). As ADA is now pervasive in the audit of journals (section 2.3), management may be less inclined to make aggressive adjustments via simple journal entries. Similarly, the analysis of entire populations of transactions using ADA should help to identify unusual activity.

Measuring the impact of the use of technology on audit quality is difficult. Audit firms' measurement of success tends to be based on usage. In section 2.2 we identify ways in which **automated tools and techniques** can enhance audit quality. We go on to explore if a relationship exists between the use of such tools and the issues that we identified during our audit inspections.

We conclude that technology has much to offer the auditor in terms of efficiency and effectiveness. It may be used increasingly to support the assessment of the reasonableness of estimates made by management. The potential for the use of technological resources to enhance audit quality is clear. However, it is no replacement for the skills and informed judgement of an experienced auditor.

2 FINDINGS OF OUR REVIEW

Audit Quality Review (AQR) monitors the quality of the work of statutory auditors and audit firms in the UK that audit Public Interest Entities and certain other entities within the scope retained by the FRC.

Our thematic reviews supplement our annual programme of inspections of individual audit firms. The reviews are deliberately more focused in scope, considering a selected area in greater depth than is generally possible in our review of audit engagements.

2.1 Objectives, scope and structure

In January 2017, we published the thematic review '*The Use of Data Analytics in the Audit of Financial Statements*', indicating that we would revisit the area if developments merited it. In the intervening period, we have seen the use of ADA increase through our routine inspection activity. We are also aware that audit firms are considering the use of other emerging technologies within the audit process. Hence, we commenced this review in the spring of 2019, expanding our scope beyond ADA to consider auditors' wider use of technological resources.

The appropriate use of technological resources has the potential to improve audit quality.

There are no standard definitions used across the audit firms in relation to their use of technology. In this report, we use the following terminology throughout. A more detailed glossary with sources and references is provided at the end of this report.

Technological resources	Umbrella term for technology used by the auditor.
Automated tools and techniques	Technology used to perform risk assessment procedures and / or obtain audit evidence. A subset of technological resources.
Audit data analytics (ADA)	A subset of automated tools and techniques relating to the 'analysis, modelling and visualisation of data for the purpose of planning or performing the audit'. For this report, we exclude procedures that involve the use of AI or machine learning from this definition.

2.2 The impact of technology on audit quality

Improving audit quality continues to be cited by all firms as a driver for the continued implementation of **automated tools and techniques**. The FRC believes that the appropriate use of **technological resources** has the potential to improve audit quality. We refreshed our definition of audit quality in the 2018 Developments in Audit report.

FRC definition of audit quality	How the use of technological resources can contribute to audit quality
High quality audit provides investors and other stakeholders with a high level of assurance that the financial statements of an entity give a true and fair view and provide a reliable and trustworthy basis for taking decisions. Auditors carrying out high quality audit act with integrity and objectivity, are demonstrably independent and do not act in a way that risks compromising stakeholders' perceptions of that independence.	• Aids professional scepticism • Analysis of entire populations demonstrates a lack of bias • Automates routine audit processes and procedures, allowing more time to focus on areas of significant judgement
High quality audit complies with both the spirit and the letter of regulation and is supported by rigorous due process and quality assurance. It clearly demonstrates how it reflects investor and other stakeholder expectations, is driven by robust risk assessment informed by a thorough understanding of the entity and its environment and provides challenge, transparency and insight in a clear and unambiguous way.	• Deepens the auditor's understanding of the entity and its processes • Facilitates robust risk assessment through the analysis of entire populations • Enables ongoing risk assessment throughout the audit process • Facilitates the focus of audit testing on the areas of highest risk through stratification of large populations • Enables the auditor to perform tests on large or complex datasets where a manual approach would not be feasible • Enables the independent reperformance of complex calculations and modelling • Improves consistency and central oversight in group audits
High quality audit provides a strong deterrent effect against actions that may not be in the public interest, underpins stakeholder confidence, and drives continuous improvement.	• Identifies instances of potential fraud • Identifies unusual patterns and exceptions that might not be discernible using more traditional audit techniques • Management awareness that entire populations will be analysed

In November 2019 we published our latest '*Developments in Audit'* review, which reported that the overall "AQR results for the 2018/19 inspection cycle were unsatisfactory, with only 75% of FTSE 350 audits reviewed being classified as good or requiring no more than limited improvements."

We observe that the use of ADA is growing, but our overall inspection findings do not report a sufficient increase in audit quality. '*Developments in Audit*' identified three themes in our overall quality findings, which we can consider in turn against our thematic review findings:

Theme 1: Challenge of management

The insufficient challenge of management is the most frequent issue we raise. Within this theme we identified four potential contributing factors: auditor mindset; a tendency to design procedures to confirm management's numbers rather than challenge them; the need to perform procedures beyond discussion; and the acceptance of unrealistic audit deadlines. **Automated tools and techniques** are infrequently used to assist with the challenge of management. However, there is the potential for audit firms to use predictive analysis in the future (section 2.6). We believe such techniques can be used to assist auditors in challenging and corroborating scenarios to facilitate better challenge of management.

Predictive analysis can be used to assist auditors in the challenge of management.

Theme 2: Revenue

Revenue is the area of highest use of **audit data analytics** beyond journal testing, with three firms encouraging analytics in this area actively to the point of mandating their use. Further analysis of our findings for 2018/19 and our findings to date in 2019/20 reveals that most of our inspection issues have arisen in revenue streams where revenue recognition was complex and ADA was not the primary audit procedure. There were a small number of audits that used ADA to audit revenue where the specific circumstances of the audited entity were not appropriate for the tool used. This is perhaps an inevitable consequence of a determined push to deployment, and we have anecdotal evidence that firms are starting to pull back from this. On these audits, the findings did not drive a 'less than satisfactory' overall assessment. So, we maintain that appropriate use of **automated tools and techniques** continues to have a role to play in the improvement of quality for the audit of revenue.

We have not seen the increased use of ADA when auditing revenue lead to the identification and adjustment of significant audit differences. What we have observed is a much better understanding of the various revenue streams by audit teams. While a better understanding of the business talks directly to our definition of audit quality (section 2.2) auditors must also be careful to direct audit effort at that which is potentially significant or material rather than populations or items that are merely interesting. However, as the use of ADA (including data capture) becomes more streamlined and automated, it appears an appropriate technique to apply to the routine elements of the balance.

Use of ADA is applied to routine elements of revenue balances.

Theme 3: Long term contracts

Accounting for long term contracts requires significant estimation, such as estimating future costs to completion and forecast revenues in the construction industry. We found that teams often struggled to challenge management appropriately in key areas of judgement and obtain sufficient evidence to support the judgements made. This included estimates of future costs and margins, forecast revenues for onerous contracts and revenue recognition for multiple-element and complex contracts.

As with theme 1, this is not an area where the **automated tools and techniques** currently deployed are used. Predictive analytics may offer some alternative scenarios to enable auditors to challenge management. The use of technology in other areas of the audit,

including managing the audit process, may assist the audit team in being able to deploy more human capital in such judgemental areas. However, this remains reliant on the audited entity meeting its own deadlines. When using the more powerful predictive techniques, auditors must be careful that the output is used to challenge management, and not as a substitute for the audited entity's work.

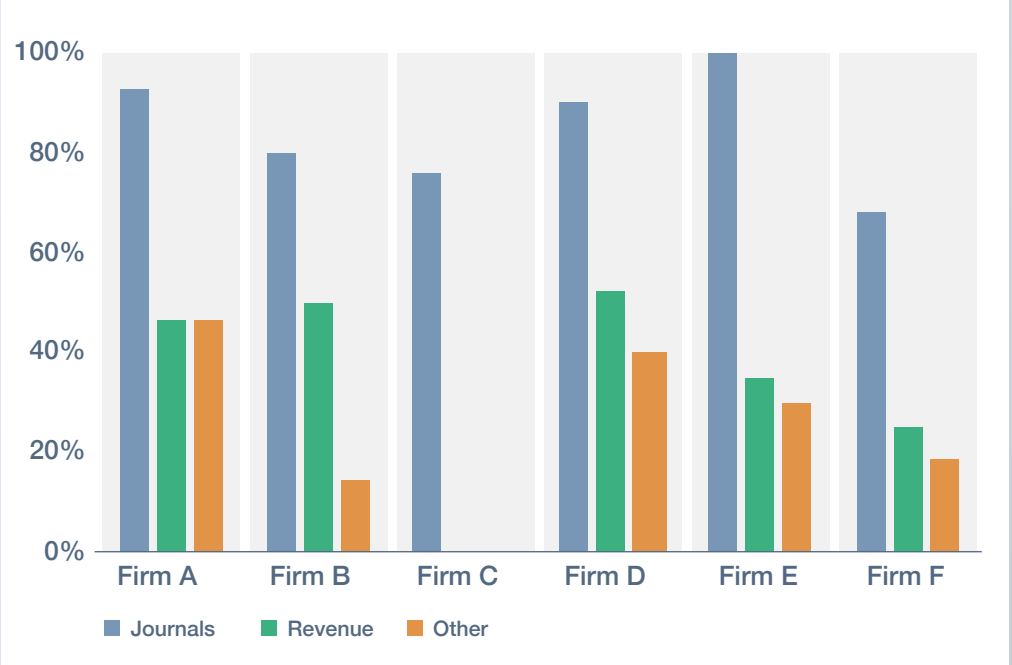
2.3 The usage of ADA has increased over the past three years

In 2017 we reported that, while large UK audit firms were investing heavily in ADA capability, the observed use of ADA was not prevalent other than in the routine use of ADA to assist with journal entry testing. In the three years since, use has increased to the point where we now expect to see the use of ADA beyond journal entry testing in most PIE audits we inspect.

Firms do not keep statistics on ADA usage in a way that allows us to make meaningful comparisons across the market. Ideally, we would like to be able to compare those audits that have used ADA to generate audit evidence. However, the statistics kept often record access to a tool rather than its eventual use in generating audit evidence.

We have, therefore, looked at the use of **automated tools and techniques** on the population of audits that we inspect. This forms the basis for the following two graphics. Note our information collection and inspection work focuses on those areas of greatest audit risk, typically significant risks and revenue. Hence, we may be understating the use of automated tools and techniques in typically lower risk areas such as payroll and fixed assets.

Usage across all AQR inspections of the largest six audit firms for the 2018/19 and 2019/20 inspection cycles



Beyond journal entry testing, we most commonly see ADA used in respect of revenue. One firm mandates the use of ADA unless formally rebutted by the audit team, and two further firms actively encourage the use of ADA in this area.

The split of effort we see in practice at each firm largely reflects the implementation approach adopted by the audit firms. Note that the 'other' category includes much of the payroll, accounts payable and bespoke analytics work we consider below in section 2.3.4.

The following table appeared in our 2017 review and has been updated to further demonstrate the direction of progress.

Deployment of standard automated tools and techniques

	Firm A		Firm B		Firm C		Firm D		Firm E		Firm F	
Year of usage	2016	2019	2016	2019	2016	2019	2016	2019	2016	2019	2016	2019
Journal Entry Testing	W	W	W	W	W	W	W	W	W	W	W	W
General Ledger Analysis (Risk Assessment)		R	R	R	R	L[a]	L	W	R	W	L	R
Revenue Analytics	W	W		W			L	W		W[b]	P	R

W Wide use, accepted norm

R Regular use, part of standard auditor 'tool kit'

L Limited use

P Pilot use

a The firm has changed its related analytics tool since 2016 and has been in a period of adoption and roll-out of new software.

b The firm has deployed bespoke data analytics in addition to a standard tool.

In 2017 we noted developments in automated tools available to audit teams to facilitate the testing of derivatives valuation and impairment. The trend across the market, particularly in relation to financial services entities, is to use specialist teams from outside the audit function to assist in the audit of these areas. These teams use a range of **automated tools and techniques** according to audited entity circumstances, but they are commissioned outside of the audit function. Because of the range of practice, it has not been possible to get comparable data within the scope of this inspection review and such tools and techniques are not included in the charts above.

In our 2017 review, three of our eight key findings related to the correlation between the level of support an **automated tool or technique** was deployed with and its apparent success. We reported that ADA was typically more effectively embedded where an audit firm had:

- Focused rollout of specific tools with central team support;
- Specialist dedicated support for data capture; and
- Methodology guidance on the purpose and appropriate circumstances for the tool or technique's use.

Overall, we have seen an increase in consistency in this area. Not only are firms now deploying tools with increased levels of support, they are also seeking to embed the tools in their methodology and workflows and deploy them via an interface that has a 'look and feel' standard to that firm. The output of the automated tools is designed to be integrated as smoothly as possible into the audit workpapers.

The evidence shows that the successful rollout of an automated tool requires a 'support package' of methodology, training and infrastructure. Firms have taken different approaches to tool rollout, with some focusing on a small number of tools with deep levels of infrastructure and support, while others have made a wider variety of tools available to audit teams with varying levels of training.

Audit quality opportunity

Focusing deployment efforts, including training, on specific areas of automated tools and techniques increases uptake by audit teams.

Audit quality challenge

We have raised issues on a small number of inspections where a firm's standard ADA technique has been inappropriately deployed due to the particular circumstances of the audited entity. Overall, we see this as an almost inevitable consequence of a push to deploy ADA and achieve momentum in uptake.

2.3.1 Audit methodology

Embedding tools within the audit methodology is a crucial enabler in the successful use of ADA. This step helps ensure that audit teams:

- Understand the audited entity circumstances where the use of an automated tool or technique is suitable (and/or those where it is not);
- Understand the assertions addressed;
- Understand what further audit procedures are required in respect of the financial statement line items being audited (and which procedures previously performed are redundant); and
- Where an automated tool or technique is deployed for risk assessment purposes only, methodology guidance can help the audit team interpret the output from the tool appropriately in terms of making appropriate judgements as part of the initial planning risk assessment.

By providing guidance in the methodology, an audit firm can practically transfer most of the burden of adherence to auditing standards (section 3.1) from the individual audit team to the central team. The ultimate responsibility rests with the RI, but his/her view is informed by the guidance. This step is one of the key drivers in the rise of the use of ADA since our last review. Where firms have mandated or strongly encouraged the use of ADA, this has only been possible because the relevant methodology has been implemented.

2.3.2 Training

There are a variety of approaches to training including:

- Classroom based
- Annual updates
- Online, on demand webinars

A mix of practice is appropriate. Face to face training allows auditors to ask questions, share experiences and dispel myths regarding tool deployment. Online training is usefully deployed close to the point of use.

2.3.3 Infrastructure

Overall, data extraction is cited as the biggest challenge faced by the audit market in successfully using ADA. A small number of audit teams, typically in the financial services sector, execute ADA by deploying software within the audited entity's own technological environment. However, typically data extraction is required for the audit team to use **automated tools and techniques**. This entails obtaining datasets from the audited entity and being able to organise this data in a way that the audit firms' standard tools can interrogate. An audit trail is required to evidence that each dataset's integrity has been maintained throughout the extraction process, and hence that the auditor is working with complete and accurate data.

Firms have invested significantly in this area, using a combination of onshore and offshore in-house skills, and proprietary and third party extraction software. The overall aim is to take the onus for data capture away from the core audit team, and to improve the process from the client's perspective by using standard procedures including tools specific to the entity's accounting system. Such standard approaches also enable audit firms to place appropriate data security controls around the captured data.

We note that not only ADA, but also many of the emerging technologies we discuss in section 2.6, require entity data. As such, robust infrastructure will be the bedrock of the data enabled audit moving forward.

Robust infrastructure will be the bedrock of the data enabled audit.

2.3.4 Bespoke audit data analytics

Bespoke audit data analytics continues to form a considerable proportion of the ADA we see in practice. These are analytics developed in response to a specific audit requirement. Given the increase in standard tools available, the use of bespoke analytics will tend to be on entities with complex information systems and data flows. Audit teams and specialists are required to work closely together; specialists should understand the scope and purpose of the analytic to be developed, and the audit team should understand what additional procedures need to be performed in relation to the underlying data.

In 2017, one of our key findings related to issues with evidencing ADA. These were of particular concern for bespoke ADA. We are pleased to report that the audit firms have made considerable progress in this area; in particular by ensuring that evidence produced by ADA specialists is incorporated into the archived audit file. While we continue to raise minor findings in relation to evidence retained, typically they are not significant enough to become inspection issues.

Audit quality reminder

The work of data analytics specialists, including those that assist in capturing the data, must be reflected in the final audit file, consistent with the auditing standards in relations to evidence, documentation and archiving.

2.4 Skill sets

Supported deployment of ADA tools leads to a requirement for staff with specialist skills. These skills are in demand across business and commerce. Four of the six firms in scope cited attracting and retaining staff with the appropriate skills as among the most significant challenges faced in deploying ADA. We sense that this is a challenge audit firms have largely been able to address to date and hence deployment has not been stalled. It requires continued activity for firms to keep abreast of their staffing needs. The firms have taken a variety and combination of approaches to developing the necessary human capital for ADA to be effective.

	Firm A	Firm B	Firm C	Firm D	Firm E	Firm F
Staff dedicated to audit	✓	✓	✓	✓	✓	✓
Staff in other service lines	✓	✓	✓	✓	✓	–
Onshore delivery centres / hubs (specialist)	✓	✓	✓	✓	✓	✓
Offshore delivery centre (specialist)	✓	✓	–	✓	–	✓
Offshore delivery centre (administrative)	✓	–	–	✓	–	–

The use of onshore delivery centres to enable specialist staff to work across UK based audits is a development not limited to ADA. Some firms have found that staff recruitment and retention is easier outside London, another driver towards the use of delivery centres.

2.4.1 Recruitment and Development of Staff

Firms are increasingly looking to develop their specialist staff rather than recruit them. This involves the creation of separate career pathways for ADA specialist staff. Personnel may be recruited at school leaver or graduate level.

Firms are formally using their Personal Development Programmes to mandate, encourage and reward the appropriate use of audit related technology, including ADA, among audit staff. This may be a constituent part of a wider objective concerning audit innovation or transformation.

2.5 The challenge of compliance with auditing standards

Use of ADA has increased even though audit standards have not been changed explicitly to address the use of technology. All six firms in the scope of our review are continuing to make progress with the implementation of **automated tools and techniques**. Firms continue to find the standards framework challenging. Their comments varied from audit standards impinging on investment and development through to demonstrating how chosen automated tools and techniques do comply with standards. Overall, the extent of use indicates that firms have found areas where they can confidently apply ADA techniques.

It remains, of course, possible to deliver a high quality audit without using **automated tools and techniques**. Indeed, the nature and complexity of some balances and transaction flows mean that the use of ADA would not be appropriate.

In section 2.3, we discuss how audit firms are deploying **automated tools and techniques** as a 'package' including methodology and supporting infrastructure. This allows audit firms to provide guidance to seek to ensure that audit evidence is obtained in accordance with auditing standards. The compliance risk for a responsible individual (RI) is lower because the critical thinking around the technique is performed by methodology experts within the central team.

Alongside this AQR Thematic Review, the FRC is issuing a discussion paper '*Technological Resources: Using Technology to Enhance Audit Quality*'. The objective is to identify practical steps we can take as the UK's audit regulator to enhance relevant standards and/or guidance, as well as generate insight which will influence our engagement with international standard setters. We encourage interested parties to respond to that document, available on our website, by 29 May 2020.

2.6 Audit firms' approach to emerging technologies

New technologies offer opportunities and further challenges. We asked the audit firms to tell us about their approach to seven areas of emerging technology, as shown in the table below. Please see the Glossary at the end of the report for detailed working definitions of the technology. To give a balanced impression of developments in an area of rapid change, the table shows the firms' stated status as for December 2019 audits. Note that these audits will fall into our next inspection cycle.

	Firm A	Firm B	Firm C	Firm D	Firm E	Firm F
TOOLS WITH THE POTENTIAL TO INCREASE AUDIT QUALITY						
Machine Learning	P	R	R	D	R	R
Natural Language Processing	R	R	R	P	P	R
Predictive Analysis	–	D	R	D	D	R
TOOLS WITH THE POTENTIAL TO INCREASE AUDIT EFFICIENCY						
Smartphone applications	D	D	–	D	D	D
Robotic Process Automation	D	D	–	D	P	P
Drones	P	P	–	R	–	–
OTHER TOOLS						
Process Mining	P	D	–	P	–	P

D Deployed

P Pilot usage

R Research being undertaken

Audit firms are considering emerging technologies as a means to improve audit quality and / or efficiency. The two are not mutually exclusive; however, we shall consider **automated tools and techniques** by their primary objective. We saw such limited consideration of process mining as an audit tool that we have not considered it in detail. We also asked the firms about the use of blockchain, sensor technology and virtual and augmented reality. The audit firms' focus with regards to blockchain is in designing audit approaches for entities that use blockchain, particularly those with balances related to cryptocurrencies. There is limited to no research activity in the other areas across the market.

2.6.1 Technologies that primarily offer audit quality improvement

We have grouped machine learning, natural language processing and predictive analysis as three automated techniques deployed with the prime objective of improving audit quality.

Such techniques, which utilise algorithms and are often categorised as sub-sets of a broader 'Artificial Intelligence' definition[2], should have much to offer as auditors deal with increasingly complex corporate entities, increasingly complex electronic transaction flows and increasing volumes of data.

Once deployed, they execute at speed and may also offer efficiency gains. However, one of their benefits is the ability to assess and potentially interpret or extrapolate entire populations of data, so the primary attraction is one of coverage (and hence quality) rather than speed.

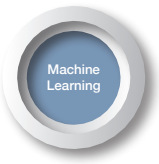
We are pleased to see audit firms researching and piloting these techniques and devoting much thought to the challenge of compliance with auditing standards. We have been impressed by the measured approach taken by the firms. As one firm said to us, "we are aware that if we get this wrong, we get it systemically wrong".

Approaches that we have seen audit firms adopt in seeking to comply with auditing standards include:

- Stabilising the algorithm before deployment. This means that the data populations that the algorithm learns with are controlled, and the same version of the algorithm is deployed for fixed periods, for example an audit season. Audit teams know precisely which version of the algorithm was used within the audit, which could then be traced back to testing performed by the audit firm's central team.
- Output demonstrating that the entire population has been subject to analysis by the algorithm and that appropriate items have been highlighted for further consideration. Visualisation is often helpful in achieving this.
- Output enabling the auditor to review the operation of the algorithm and assess whether the output is appropriate. In the same way as the work of each member of the audit team should be reviewed, so should the operation of an algorithm. Ensuring that the algorithm provides output at an appropriately granular level should facilitate this.

Machine Learning

Machine learning provides the opportunity to identify unusual patterns and exceptions in large populations of data that might not be discernible using more traditional techniques (which commonly include setting expectations of what would be unusual in advance). Journals testing is one area where firms are seeking to use machine learning to identify journals with characteristics that are unusual in relation to the population, without predefining such characteristics as noted in ISA (UK) 240 para A23. This means the audit testing is less predictable and hence potentially more robust.



[2] For this review, artificial intelligence is defined as the use of computer systems to perform tasks normally requiring human intelligence.

Natural Language Processing

The pilot use that we have observed involved extracting and structuring contract information from source documents (largely unstructured text) into audit workpapers for further analysis. We liked the combination of using an intelligent automated tool to perform a time consuming and mundane task for a 'human' auditor, leaving the auditor free to perform the more qualitative analysis.

Predictive Analysis

The informed and effective challenge of management is a cornerstone of a high quality audit. It is the area where we identify most issues on our audit inspections (see section 2.2). The use of predictive analysis can assist the auditor in forming independent expectations of events, conditions or outcomes. This may be for current outcomes, such as forming an independent expectation when performing substantive analytical procedures, or future events such as when auditing judgements around going concern or impairment. The auditor must identify which are the significant scenarios to record on the final audit file to demonstrate the nature and extent of their work and the conclusions reached.

However, balanced against the possible opportunities outlined above, there are dangers to be avoided, including (but not limited to):

- Systemic error or bias due to poorly designed or chosen algorithms or poor quality data used in the learning process.
- Applying standard algorithms to inappropriate circumstances. To be an effective investment, audit algorithms need to be capable of being applied to multiple, similar (but not identical) populations on different audited entities. The potential scope of the algorithm must be clearly defined and understood before deployment by an audit firm and in turn by each audit team.
- The identification of too many false negatives or outliers in populations, or of items that would not in isolation or in aggregate lead to a material misstatement, misdirecting audit effort in the follow up. The auditor should not ignore outliers, and while not required to test each one unless identified as a true exception, the auditor must provide a reasoned explanation for their treatment.
- Over auditing, potentially leading to time constraints in other areas of the audit.

In signing an Independent Auditor's Report, auditing standards require the RI to be assured that they have first obtained sufficient appropriate audit evidence. If part of this evidence has been obtained using an algorithm, the challenge to the RI is to demonstrate that the evidence gained is sufficient and appropriate.

This challenge also faces other industries and markets looking to use artificial intelligence to inform decision making. How does the individual or corporate body ultimately responsible for that decision gain confidence in the method?

The words 'interpretability' and 'explainability' are standard terms used in this context.

RIs must be able to demonstrate that audit evidence obtained using an algorithm is sufficient and appropriate.

For clarity, we shall use 'interpretability' as the ability to use the results of the algorithm appropriately in context, and 'explainability' as the ability to explain how the results have been deduced.

The RI should be able to interpret the results of an algorithm. But how does the RI deal with 'explainability' – and ultimately be able to explain the basis for the audit opinion? The responsibility for demonstrating the interpretability and explainability of the algorithm rests with the RI. However, it is reasonable that the explainability of the algorithm would be handled by the audit firm centrally, before deployment.

The use of AI presents many audit quality opportunities, accompanied by many challenges. We have set out in section 4.1 our expectations of audit teams and audit firms using algorithms to obtain audit evidence.

2.6.2 Technologies that primarily offer efficiency

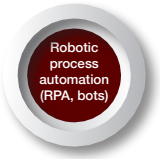
Collecting and collating audit evidence involves administrative and repetitive tasks that do not require judgement and hence lend themselves to automation. It may not be possible to tell from the final audit file whether an automated tool has been used to populate the workpapers. While the primary objective is efficiency, the use of automated techniques when properly implemented may also improve quality by guarding against human error.

Smartphones

This was the most widely deployed technology in the field with the most popular application being in physical stock counts. Firms have developed their own 'apps' which auditors can use to follow and record the results of inventory count procedures, streamlining the stock counting process.

Robotic Process Automation

Robotic Process Automation[3] (RPA) can be used to populate audit working papers from a set of underlying audit evidence. Under our working definition of RPA, no intelligence is applied, it is purely the automation of a repetitive task. The output from an RPA may be very similar to that from a tool that uses machine learning or natural language processing to populate workpapers. The difference is the process. In general, the audit firms' approach to the implementation of RPA is to deploy limited functionality but make it available to a wide number of audit teams. One firm had implemented such a technique at the time of our research, with other firms implementing RPA for December 2019 year end audits.



Drones

While there is much hype surrounding drones (Unmanned Aerial Vehicles or UAVs) in the emerging technology landscape, their use to date within the UK audit market has been limited. Primarily their purpose is as 'eyes in the skies', reducing practical issues associated with auditors inspecting and verifying assets in inaccessible places.

Drones may be fitted with equipment for surveying and measurement (in addition to cameras) that assist in the calculation of, for example, stockpile quantities.

[3] A definition of robotic process automation is provided in the Glossary at the end of this document

Globally, we are aware of drones being used by auditors to assess the existence and condition of assets in the following industries: extractive, agriculture, construction and infrastructure. UK based PIE audit teams may be more likely to find overseas component auditors using drones.

Laws and regulations surrounding the use of drones are developing rapidly, with around 25% of countries tightening rules over the past year and a small number banning drones altogether. In the UK it is now necessary for anyone flying a UAV to qualify and register with the Civil Aviation Authority (CAA), and all operators of UAVs (those responsible for the aircraft itself) must also register with the CAA. There are further regulations regarding where a UAV may be flown. We envisage that the use of drones in the UK audit market will be a niche area for qualified and registered specialists.

Audit quality reminder

Where automation is used to assist the auditor in creating and collating workpapers and evidence for the final audit file, there should still be a member of the audit team accountable for the performance of the work with another member responsible for review, in accordance with ISA (UK) 230 paragraph 9.

2.7 Third party vendors and service providers

Audit firms across the market have used third party products in the extraction and analysis of audited entity data for many years. As the possibilities created by the developments in technology have increased, so has the range of products offered. Not only is the scope of product offerings increasing, now a number of third parties offer services to the audit firms. Such services may include data extraction, hosting of audited entity data, running of scripts and algorithms and interceding in audit circularisations.

We have engaged with a number of these third parties to facilitate mutual understanding of technological developments in the audit market and the regulatory landscape. Some meetings were arranged in response to this review; some were part of our usual market outreach. We have not assessed the suitability of any individual company's product or service offering.

Audit quality opportunity

Firms can access specialist skill sets and technological resources without bearing the full cost of investment or building their own internal teams. The effort required by entity management in extracting data may be reduced by the use of third party extraction tools and techniques.

Audit quality challenge

Audit firms must be transparent with audited entities regarding the role of the third party, the relative responsibilities with regards to handling data and continue to ensure all audit related activities are conducted in accordance with ISQC1[4].

[4] International Standard on Quality Control (UK) 1

Audit quality challenge

Third parties are outside the direct scope of the FRC as audit regulators. Audit firms should assess both the product or service that they are obtaining and the reputation, competence and capabilities of the service provider in the context of the intended use of the resource.

Audit quality reminder

In all circumstances, the responsibility for the collation of sufficient, appropriate audit evidence in accordance with ISA (UK) 500 rests with the auditor.

2.8 Other uses of technological resources

We note the following uses of technological resources at the audit firms that were not subject to the detailed consideration during our review, but are included to complete the technology picture.

2.8.1 Audit platforms including methodology and workflows

To varying extents, all six firms use technology to integrate their methodology into a workflow, collate and record audit evidence and demonstrate review. These platforms also facilitate the archiving of the final audit file. Some audit platforms facilitate centralised monitoring of audit progress including identification of certain audit quality indicators.

Increasingly, ADA output is automatically incorporated into the workflow, populating lead schedules and risk assessment modules. Standard automated tools and techniques may be accessible via the audit platform, with output in the form of working papers that have the 'look and feel' specific to the audit firm. Such integration helps enforce the 'business as usual' approach to standard ADA tools, and makes use as straight forward as possible for the audit team.

The consistent rollout of audit platforms across networks facilitates standardisation of audit approaches. Dependent on specific local laws and regulations regarding the sharing of workpapers cross borders, the audit platform can facilitate the sharing of files between group and component teams cross border.

2.8.2 Collaboration portals

Firms use collaboration portals to assist audit teams with communicating and exchanging information with audited entity management. They provide a more secure method of transferring data than email. Collaboration portals may be integrated into the audit platform.

The status of information requests is visible, improving project management on both sides.

2.9 Stakeholder engagement

The use of technology in the audit continues to grow, making this an important area of focus for all stakeholders including regulators, external auditors, audit committees, investors and management.

2.9.1 Audit committees

Audit committees take a proactive role in detecting, understanding and acting on risk. The use of technology can provide far greater insight into an entity's performance, reducing manual effort to sift through mountains of data to spot potential problems and prioritise issues. This is important since not all audit committees have members with sufficient IT skills or experience to challenge the audit team.

We invited Audit Committee Chairs (ACCs) to discuss the use of technology in audits.

ACCs described the extent of ADA and other technologies as "varying". While they all acknowledge that automated tools and techniques are "commonly used for journals", they see less extensive use across other financial statement balances. This is consistent with the findings from AQR inspections (see section 2.3).

They also observe the use of technology is more customary within financial services entities as the "volume and nature of transactions lend themselves more to analytics being applied". Examples seen in practice include using ADA in non-judgmental areas such as bank confirmations and recalculation of mortgage interest, and deploying AI to read 100% of customer complaints. However ACCs recognise that "one approach cannot fit all" as automated tools and techniques are not always appropriate or possible where entities have fragmented or complex systems, data quality issues or have other business priorities.

Through the discussion we identified audit quality challenges and opportunities relating to the use of technology.

ACCs welcome ADA when exception reporting is accompanied by visualisations, noting "pictures speak a thousand words" as it assists the ACC to understand how the audit team has assessed risk and targeted their testing.

ACCs questioned whether ADA procedures could detect missing transactions as they believe that ADA can "only analyse data that is present". They would like to see auditors being "bold enough to expand their procedures", using **automated tools and techniques** to go beyond a historical-looking audit.

Audit quality opportunity

The use of visualisations can add value to the audit by assisting ACCs with with a clearer understanding of the audit approach and key findings.

Audit quality opportunity

Audit firms could use ADA or AI more for forward-looking or 'predictive purposes' to assess future cash flows or the ability to meet bank covenants.

In Section 4.2, we provide questions to assist Audit Committees Chairs when challenging audit firms on their use of technology in the audit of financial statements.

2.9.2 Investors

We invited investors to discuss the use of technology in audits, again identifying audit quality opportunities and challenges.

While investors are not always aware of whether the audit approach has used **technological resources**, they welcome the use of technology to drive audit efficiencies and audit quality. They perceive benefits from assessing entire populations of transactions, providing "greater assurance to shareholders".

When asked whether the speed of technological change in the audit is keeping pace with the entity's technological change, there was a consensus that the entity's technology landscape could restrict what was possible to do on the audit. Investors recognise that "technology has not been built with the auditor in mind" and where entities are still heavily spreadsheet driven or using legacy systems, auditors are limited in the type of technology they can use.

Audit quality opportunity

Using technological resources can increase the coverage of audit testing.

Audit quality challenge

The appropriate use of technology is dependent on an entity's system landscape and quality of data.

3 CONTEXTUAL INFORMATION

3.1 Regulatory landscape

It is the FRC's long standing view that the auditing standards should remain principle based. In respect of technology, the speed of change is such that standards must be adaptable to evolving tools and techniques and not tied into current technological practice. ISA 315 (Revised) (approved by the IAASB at their September 2019 meeting) and the exposure draft for ISA 220 demonstrate the direction of travel: as standards are revised, they will refer to the use of **technological resources**, and provide examples where **automated tools and techniques** may be used.

In January 2018, the IAASB's Data Analytics Working Group (DAWG) produced its feedback statement '*Exploring the Growing Use of Technology in the Audit, with a Focus on Data Analytics*', drawing on submissions received in response to its '*Request for Input*', published in September 2016 (this research was ongoing at the time of our 2017 review). One of the key messages reported was that extant ISA's are "not broken and should remain principles-based, but need to reflect the digital era in application guidance. Respondents overwhelming described a strong desire for practical guidance on the use of data analytics technology. Most respondents believed that the principles in the extant ISAs are still appropriate and accommodate the use of data analytics, and caution against prematurely rushing to change requirements in the standards".

In August 2019 the IAASB published its Technology Workstream Plan[5]. This outlines the IAASB's plan for "identifying, developing and issuing non-authoritative guidance material that addresses the effect of technology when applying certain aspects of the ISAs". An overview of the plan is provided in the second instalment of the IAASB publication '*Tech Talk*', released on 26 November 2019[6]. This notes the preliminary list of topics as including:

- The impact of new technologies on the auditor's documentation.
- The question about whether an automated audit procedure can be both a risk assessment procedure and a substantive procedure.
- How the nature and number of sources of information affects planning and performing substantive analytical procedures, in particular the use of data analytic tools.

As noted in section 2.5 the FRC is releasing a discussion paper requesting responses from stakeholders to inform our audit policy work programme and also our engagement with international standard setters.

3.2 Data security and confidentiality

The capture, storage and processing of entity data presents firms with challenges concerning data security and data protection. Since our previous review in this area, the General Data Protection Regulation (GDPR) has come into effect, highlighting to both audit firms and audited entities the requirement to be clear on respective responsibilities regarding data handling and data security.

The implementation of appropriate policies and procedures in relation to data security is, therefore, a necessary part of the effective deployment of **technological resources**. Such considerations are part of our Audit Firm Monitoring Approach[7]. In 2017/18 the FRC reviewed the risk management policies and procedures over information security for the audit firms subject to this thematic review. We used a maturity framework based on recognised standards to benchmark the firms. We provided feedback based on the information security

[5] https://www.ifac.org/system/files/uploads/IAASB/20190910-Technology-Workstream-Plan.pdf

[6] https://www.iaasb.org/publications/iaasb-tech-talk-november-2019

[7] Our Audit Firm Monitoring Approach is described at https://www.frc.org.uk/auditors/audit-firm-monitoring-approach

risks affecting the firms, including areas for improvement, with the outcomes being reported privately to senior management and the independent non-executives of each audit firm. These matters are outside the scope of this review.

3.3 Thematic review methodology

Our approach to this thematic review can be summarised as follows:

- We asked each firm to complete a questionnaire in May 2019 regarding their current use of ADA and approach to emerging technologies. The responses to the questionnaires were then debriefed through meetings with each firm.
- We considered the firm's use of technology that we had observed during our routine audit inspection process, including any findings raised. Where we had no recent experience of particular automated tools or techniques that were in use by the firms, we arranged demonstrations.
- We attended presentations regarding the firms planned future use of technology, including observing test and pilot uses of emerging technology.
- We held meetings with some third party vendors of audit related tools and technology to understand developments in the market. This is part of our regular market outreach, however some meetings were arranged to coincide with the research phase of this review.
- We held discussions with standard setters, professional bodies and other international regulators to discuss the use of technology by audit firms.
- Our IT audit inspectors who led our research update their knowledge on an ongoing basis through attendance at relevant seminars, workshops and forums relevant to the subject.
- We read and reviewed relevant literature, including but not limited to:
  - Exploring the Growing Use of Technology in the Audit, with a Focus on Data Analytics – Feedback Statement prepared by the staff of the IAASB, January 2018
  - IAASB Tech Talk, May 2019 and November 2019 editions
- Our initial research results were reviewed by and discussed with other teams in the FRC, including the Audit and Assurance team responsible for audit standard setting in the UK, and the Financial Reporting Lab which runs the Digital Future project looking at the impact of AI on corporate reporting.
- The results of our review were presented to, and discussed with, each of the audit firms.

3.4 Brydon Review

Sir Donald Brydon's report on the '*Independent Review into the Quality and Effectiveness of Audit*' was published in December 2019. Section 24 of the report addresses Technology. We believe that the observations made in this report are consistent with the Brydon Review.

Further consideration of the implications of the Brydon Review on the audit firms' use of technology is to be found in the associated discussion paper '*Technological Resources: Using Technology to Enhance Audit Quality*'.

The six firms in scope for this review were:

- BDO LLP
- Deloitte LLP
- Ernst & Young LLP
- Grant Thornton UK LLP
- KPMG LLP
- PwC LLP

4 REVIEW OUTPUTS

4.1 FRC expectations of firms deploying artificial intelligence

In signing an Independent Auditor's Report, auditing standards require the RI to be assured that they have first obtained sufficient appropriate audit evidence. When an algorithm has been used to obtain part of this evidence, the challenge to the RI is to demonstrate that the evidence gained is sufficient and appropriate.

As noted in section 2.6.1, we are clear that the responsibility for demonstrating the interpretability and explainability of the algorithm rests with the RI. However, it is reasonable that, in practice, the explainability of the algorithm would also be handled by the audit firm centrally, before deployment.

Based on our current understanding in our inspections we expect that, where an algorithm is used, the audit file should retain evidence regarding:

Audit file

- What algorithm was used, including version number, with details of how to access that algorithm post archive.
- The testing of the algorithm and approval for its use centrally by the audit firm. This could be in the form of an internal certification.
- Why the audit team considered that use of the algorithm was appropriate in respect of the audited entity circumstances.
- The complete and accurate extraction of data submitted to the algorithm from its source.
- Ensuring that the entire population had been considered by the algorithm.
- Consideration of the appropriateness of the output of the algorithm and further audit procedures adopted as appropriate.
- Review of the execution and output of the algorithm by a member of the audit team on a contemporaneous basis.

FRC EXPECTATIONS FOR ALGORITHMS

We expect the firm to retain evidence centrally relating to its development (where applicable), testing and approval of the algorithmic approach including (but not necessarily limited to):

Central development

- What version(s) of the algorithm have been deployed for use in the audit firm and when; what version(s) have been retired from use and when.
- The overall project plan; from selecting an audit area where machine learning could be used to deployment and ongoing support.
- The basis on which the underlying algorithm was selected.
- The development of the algorithm and the overall tool through structured / unstructured learning, including the source of the training data sets.
- The source of the test data sets and the success criteria according to which testing was performed.
- The characteristics a 'live' population should exhibit in order for it to be appropriate for algorithmic analysis.
- Details of training, guidance and coaching provided to audit teams on deployment.

FRC EXPECTATIONS FOR ALGORITHMS

As discussed in section 2.7, we are aware that as the potential technologies available to the firms increase, so do the number of third parties active in the marketplace, offering services from 'just' the algorithm to be taught by the audit firm, to a service that produces results. The expectations set out above hold whether the audit firm uses an algorithm or technique largely developed inhouse or uses a third party service provider.

4.2 Questions for audit committees

With advances in technology, external auditors are turning to innovation to enhance quality and drive value into the audit. While the extent of use of **technological resources** may vary across external audit teams, audit committees may wish to consider the following questions:

Tender

- What are some of the **technological resources** that the external auditor is exploring for use in the audit?
- What investment is the external auditor making in audit innovation, and how do those investments translate to enhance audit quality and value for the organisation?
- With respect to technology and innovation, how is the external auditor differentiating itself from competitors to add value to the audit?

Execution

- Does the use of ADA and other technology differ between the tender document and the first year audit?
- How does the external audit team ensure it has adequate knowledge and skills to perform the planned ADA routines and evaluate their results?
- How do **automated tools and techniques** improve the effectiveness, efficiency and overall quality of the audit?
- What insights is the external auditor able to provide about the entity and its financial and internal controls processes through the use of new technology?
- Did any automated tools and techniques identify specific higher risks of material misstatement or actual material misstatements of the financial statements?
- Have there been any challenges in obtaining data in a usable format? Has the external auditor received appropriate support from the management team to enable the use of **automated tools and techniques** in the audit?
- How does the external auditor store and handle the entity's data? What data is retained and for how long is it retained? What steps are taken to ensure the security, confidentiality, and privacy of data?
- Were there any **automated tools and techniques** routines the external auditor planned to perform but was unable to do so?
- To what extent is external audit engaging with the entity's internal auditors to fully utilise their knowledge of risk and operating environments and apply this to ADA routines?

4.3 Agenda for FRC arising from this review

4.3.1 Work programme for firm's 'certification' process

As competent authority, the FRC has responsibility for regular monitoring and mitigation of risks in the audit market. We will develop and execute a work program as part of our firmwide procedures to review in more detail the governance and risk management processes each audit firm goes through prior to releasing an automated tool or technique for use across their audit practice.

4.3.2 Discussion Paper; '*Technological Resources: Using Technology to Enhance Audit Quality*'

The findings of this review have been reflected in the drafting of the discussion paper '*Technological Resources: Using Technology to Enhance Audit Quality*'. Stakeholder responses to the discussion paper will be used to inform the FRC's audit policy work programme, and also our engagement with international standard setters.

4.3.3 Future inspection and thematic reviews

Technological resources are now used across all elements of the audit process. We will assess the use of ADA and other technologies in our review of individual audits, including selecting areas to review and reviewing the use of ADA in high risk audit areas. We will consider the opportunities and challenges associated with the use of technology where relevant on each future thematic review we undertake.

GLOSSARY OF TERMS AND DEFINITIONS USED

Term	Source / Reference	As used in this review
Technological Resources	Proposed ISA 220 revised, para A56 – A58	Umbrella term for technology that assists the auditor performing risk assessment procedures, obtaining audit evidence and / or managing the audit process.
Automated Tools and Techniques	Proposed ISA 315 revised explanatory memorandum, para 20-23	Technology used to perform risk assessment procedures and / or obtain audit evidence. A subset of technological resources.
Audit Data Analytics (ADA)	As used in our 2017 review, taken from the IAASB Data Analytics Working Group's Request for Input dated September 2016	A subset of Automated Tools and Techniques. "The science and art of discovering and analysing patterns, deviations and inconsistencies and identifying anomalies, and extracting other useful information in data underlying or related to the subject of an audit through analysis, modelling and visualisation for the purpose of planning or performing the audit." For the purposes of this review, an ADA or ADAs are data analytic techniques that can be used to perform risk assessment, tests of controls, substantive procedures (that is tests of details or substantive analytical procedures) or concluding audit procedures. For clarity, we do not use the term ADA to refer to automated tools and techniques that involve the use of artificial intelligence or machine learning in this report.

EMERGING TECHNOLOGIES

Augmented reality is an interactive experience of a real-world environment where the objects that reside in the real-world are 'augmented' by computer-generated perceptual information. The overlaid sensory information can be constructive (i.e. additive to the natural environment) or destructive (i.e. masking of the natural environment) and is seamlessly interwoven with the physical world such that it is perceived as an immersive aspect of the real environment.

Use of algorithms and statistical models by computer systems to perform a specific task without using explicit instructions, relying on patterns and inference instead. Machine learning algorithms build a mathematical model of sample data, known as 'training data', in order to make decisions without being explicitly programmed to perform the task.

Virtual reality is an interactive computer-generated experience taking place within a simulated environment. It incorporates mainly auditory and visual feedback but may also allow other types of sensory feedback.

Blockchain (also known as a distributed ledger) is a type of shared database which creates a permanent record of transactions across a number of participants in a network. Any changes made to the data are clear to all participants.

A branch of artificial intelligence that helps computers understand, interpret and manipulate human language.

Analysis of current and historical data (including transactional data) to make predictions about future or otherwise unknown events. Predictive models capture relationships among many factors to allow assessment of risk associated with a particular set of conditions, guiding decision-making.

Use of sensors (tactile, temperature, pressure, flow measurement) to detect events or changes in the environment and send the information to other electronics for processing.

Use of mobile devices for multimedia functionality (including video and cameras) or paperless recording.

Drones are unmanned aerial vehicles (UAV). The flight of UAVs may operate with various degrees of autonomy either under remote control by a human operator or autonomously by onboard computers.

A software application that runs automated tasks (scripts). Typically, bots perform tasks that are both simple and structurally repetitive at a much higher rate than would be possible for a human alone.

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